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Project Report

Linking laboratory and field studies of the mineralogical and iron isotope composition of banded iron formation in western Australia.

This 2010 Lewis and Clark grant covered participation in an excursion after the 5th International Archean Symposium in Perth, Western Australia. The excursion departed Perth the morning of August 10th and returned to Perth on September 18th, allowing for 8 full days of exploration and education around Western Australia. This excursion provided a means to investigate rocks of Archean age (~1.25 to 3.75 Ga) that are of significant importance to out understanding of the conditions on early Earth, and the evolution of life through deep geologic time. The excursion was lead by Martin Van Kranendonk of the Geological Survey of Western Australia, and was attended by 20 scientists specializing in Archean geology and microbiology. We departed from Perth on 4X4 off-roading busses, drove up the western coast of Australia through Shark Bay, and headed east in to Paraburdoo, eventually cutting up north to Port Headland, allowing a thorough investigation of the Pilbara craton.

The main goal of this field excursion was to gain a better understanding of the potential role of bacteria in the deposition of Archean sedimentary rocks. Although many of these rocks have previously been investigated, and their geochemical and physical data exists in the literature, the main purpose of this excursion wasn't sample collection, but rather to gain a better insight and appreciation for the deposition and geologic history of these strata. This comprehension is key in order to design and execute laboratory experiments that test and further our understanding of the role of microbiology in the formation of these Archean rocks.

One key outcome of this excursion was identification of Archean microbial mat structures, including stromatolites, in the rock record. Figure 1 provides a summary of some microbial community features observed, including live stromatolites as well as images from 4 different outcrops illustrating the range of stromatolite and microbial mat

textures observed in the rock record. The excursion began with an opportunity to snorkel with, and make close observations of, living stromatolites in Shark Bay. These live specimens quickly were replaced by fossils, and an array of diverse textures and morphologies were examined in the field, with attention focused on how much morphology can tell us about the role of bacteria in the formation of these structures. Images, such as those below portray the identified microbial structures as lifeless 2-dimentional objects, when in reality, identification as microbially-derived structures also requires an understanding of the depositional history of the area and the overlying geology, which is what was taught on this excursion.

Banded iron formations (BIFs) and other Archean chemical sedimentary rocks were seen through out the rock record in Western Australia. These rocks, which alternate between Fe-rich and Fe-poor layers, are unique in Western Australia due to their ubiquity and good preservation. Figure 2 provides an image of two different BIFs, and one chemical sedimentary rock observed and discussed on this trip. The Dales Gorge member of the Brockman iron formation (2.4 to 2.46 Ga) is one of the most famous Archean deposits, and field observations were made at several stops in order to fully examine and characterize this BIF.

The Lewis and Clark provided necessary support to finance this excursion. This trip represented an invaluable opportunity for this young scientist to be able to witness and observe key Archean deposits in the field, while engaging in active discussions with other scientists as to their formation and depositional history. In addition to tangible products of this grant, such as field notes and photographs, this excursion represented an immense source of inspiration and motivation for future research. Specifically, how can laboratory experiments be designed that produce the geochemical features observed in Archean rocks, but more importantly, how do these results fit into the bigger pictures and large-scale features observed from the field?

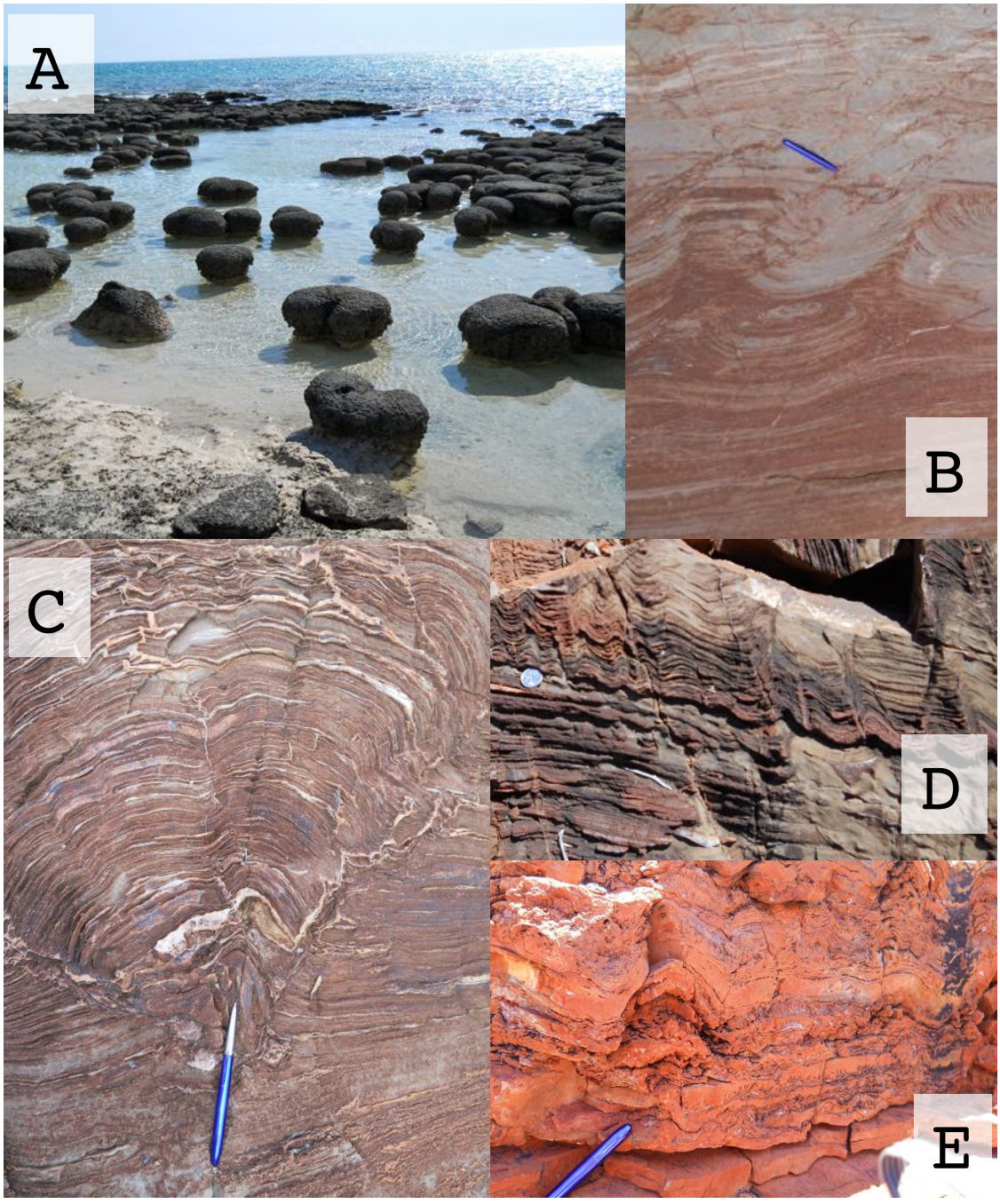

Figure 1: Images of microbial community structures through out Western Australia. A: Modern living stromatolites in Shark Bay, Western Australia. These modern microbial communities tower out of the hyper saline water of shark bay. A tan-grey modern microbial mat in the bottom left of this image illustrates another morphologically distinct modern microbial sedimentary structure. B: Preserved stromatolitic carbonate from the 1.8 Ga Duck Creek Dolomite C: Large domical stromatolite from 2.72 Ga Tumbiana Formation D and E: Crenulated microbial mat structures preserved at the 3.35 Ga of the Strelley Pool Formation, and the 3.48 Ga Dresser formation at North Pole Dome respectively.

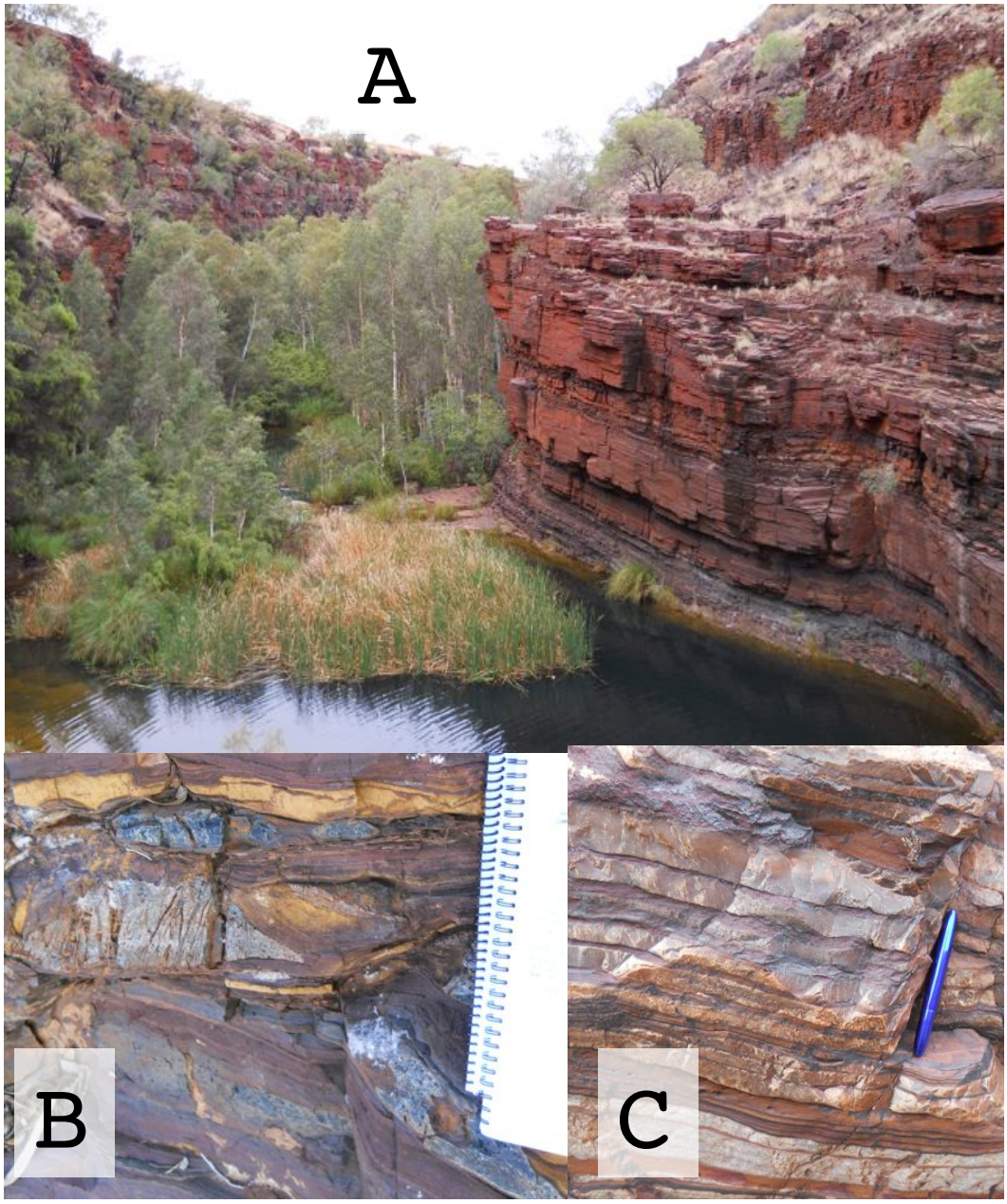

Figure 2: Images of BIFs and chemical sedimentary rocks observed and described in Western Australia. A: Circular Pool in Karijini National Park, 2.4 to 2.46 Ga Dales Gorge Member of the Brockman Iron Formation. Note red and black depositional layers on the right side of the photo indicating macrobands which were caused due to sea level fluctuation. B: Interbedded Fe-rich layers (red), Fe-rich carbonate (yellow), and chert deposits (grey) in the 1.89 Ga Duck Creek Domolite. C: Banded red, white, and bluish-black chert from 3.46 Ga Marble Bar Chert Member in the upper Duffer Formation.